SECTION III—FORECASTS.

FORECASTS AND WARNINGS FOR AUGUST, 1915, WASHINGTON, D. C., DISTRICT.

By H. C. FRANKENFIELD, Professor of Meteorology.

[Dated Sept. 27, 1915.]

GENERAL PRESSURE DISTRIBUTION OVER THE UNITED STATES AND CANADA, INCLUDING THE SANDWICH AND ALEUTIAN ISLANDS, ALASKA, AND THE WESTERN PORTION OF THE MIDDLE ATLANTIC OCEAN.

Pressure was nearly normal throughout the month at Honolulu, with greatest departure occurring during the low-pressure period on the 27th and 28th. However, the lowest barometer reading was only 29.92 inches. About one-third of the reports were missing from the Dutch Harbor station in the Aleutian Islands, but the reports received indicate that pressure was generally above normal, except from the 11th to the 16th, inclusive, when it was quite low. The highest pressure occurred during the first five days of the month and on the 19th and 20th. Over Alaska pressure was generally low throughout the month, except between the 17th and 24th, inclusive, and during much of the month the barometer readings were considerably below normal. The high pressure on the 19th and 20th was equally marked. These marked changes over Alaska did not extend eastward and southward, and over the Canadian northwest pressure did not depart much from the normal throughout the month. Over eastern Canada conditions were somewhat more active, especially with regard to high pressure, but there were no changes of marked character, except in the Hudson Bay region, where a pronounced high area on the 17th was followed by an equally pronounced low area a week later.

The effects of the tropical disturbance of the second decade of the month were limited to the West Gulf States and the lower Ohio Valley. With this single exception barometric conditions throughout the United States do not deserve special mention. Pressure slightly above normal ruled in the West and the extreme Northwest, while in the East and South it was slightly above normal during the first half and slightly below during the second half of the month, and the same conditions prevailed over the western portion of the Middle Atlantic Ocean.

STORM WARNINGS.

The principal storm of the month, the great tropical disturbance of August 10–23, is described in another portion of this REVIEW. With this exception the weather of the month was practically featureless so far as storm warnings are concerned. The disturbance that appeared over central Florida on the morning of the 1st developed considerably during the ensuing 24 hours, and northeast storm warnings were therefore ordered from Fort Monroe to Savannah and southeast warnings at Jacksonville. During the next 24 hours moderate gales occurred along the South Atlantic coast and storm warnings were extended northward to Boston, the storm in the meantime having moved to southern Virginia with somewhat increased intensity. At the same time another disturbance that developed over the Middle West had reached Indiana, and northeast storm warnings were therefore ordered at 10 a. m. of the 3d on Lake Huron, and at 2 p. m. on eastern Lake Superior and northeastern Lake Michigan. Moderate gales occurred over these sections during the day and night of the 3d, and on the morning of the 4th the southern storm was central over southeastern Pennsylvania, while the western one was still over the Upper Lakes with diminishing intensity. As high pressure continued over New England and the Canadian maritime Provinces, the northeast storm warnings were continued from Boston to Sandy Hook and extended northward to Portland, Me. Moderate to fresh gales occurred on the New Jersey and southern New England coast during the 4th, but by the morning of the 5th pressure was rising generally and the warnings were lowered at the expiration of the 24-hour period. There were no other storm warnings during the month, except on the 20th, when the West Indian storm was central over the lower Ohio Valley. This storm had not yet presented any indication of rapid disintegration and northeast storm warnings were therefore ordered for the Lower Lakes, Lake Huron, and the central and southern portions of Lake Michigan. There were, however, no high winds on the Lakes, although in the Ohio Valley and portions of the middle Mississippi Valley moderate gales occurred.

Several small craft warnings were ordered during the month for moderately strong winds that occurred in various localities.

FROST WARNINGS.

On the morning of the 24th high pressure with low temperature covered the Northwest and warnings of possible light frost, if the weather cleared, were issued for upper Michigan. This warning was not verified owing to the unexpected appearance of a low-pressure area to the northward, but as pressure continued high in the Canadian Northwest, the warnings were repeated on the following morning. While the minimum temperatures were quite close to the frost line, no frosts were reported at regular Weather Bureau stations. As pressure was still rising over the Lake region, frost warnings were again issued for upper Michigan and also for northeastern New York, northern Vermont, northern New Hampshire, and northwestern Maine, and on the morning of the 27th light frosts occurred as forecast. They, however, extended into lower Michigan where no warnings had been issued. As conditions had changed but little, further warnings were issued on the morning of the 27th for northern lower Michigan, eastern and southern upper Michigan, the lower Lake region, except Ohio, the interior of eastern New York, western Massachusetts, and northern New England. These warnings were verified from New York eastward, but not to the westward, as a low-pressure area over North Carolina and another in Minnesota caused increased cloudiness with rising temperature.

The Minnesota disturbance was followed by another marked rise in pressure, and on the morning of the 29th

frost warnings were again issued for upper Michigan and northern and western lower Michigan, and the warnings were partially verified. On the 30th frost warnings were issued for eastern upper Michigan, lower Michigan, Indiana, and northern and central Ohio and were fully verified, except over northern Michigan. At this time (31st) high pressure and low temperature prevailed over the Ohio Valley and frost warnings were therefore issued for the eastern and southern portions of West Virginia, but they were apparently not verified.

Chicago District.—Frost warnings were issued for the cranberry marshes of Wisconsin on the 18th, 24th, 25th, 26th, 27th, 29th, and 30th; also, on the 28th, frost being indicated for the night of the 29th–30th, an advisory warning was issued apprising the cranberry growers of that fact, so as to prevent the water being drawn off from the bogs on the 28th. The warnings of the 18th, 26th, 27th, 28th, and 29th were fully verified, while that of the 30th was partially verified.

Warnings of light frost in exposed places of the lowlands of the tobacco region of Wisconsin were issued on the 24th, but cloudiness prevented frost formation. No special warnings were sent to the tobacco region after the 24th, due to the fact that this office was informed on the 25th that tobacco cut within about 10 days of that date would be a total loss, as the crop was immature on account of the unusually cool summer.—*Chas. L. Mitchell, Asst. Forecaster.*

Frost warnings for the several States were issued as follows: 24th—exposed places in northeastern Minnesota; 25th—northern Minnesota and northeastern North Dakota; 26th—eastern North Dakota, north and central Minnesota, and lowlands of Wisconsin; 28th—North Dakota, northwestern Minnesota, extreme northern South Dakota, and northwestern Wyoming.

The warning of the 24th failed of verification, while that of the 25th was fully, and those of the 26th and 28th were partially verified.

The storm warnings in the New Orleans district are covered in the special report on the West Indian storm. No special warnings were issued in the Denver (Colo.), San Francisco (Cal.), and Portland (Oreg.) districts, except in the latter, where "fire wind" forecasts were issued to advantage on the 18th, 19th, 20th, and 21st.

THE TROPICAL STORM OF AUGUST 10, 1915.

By H. C. FRANKENFIELD, Professor of Meteorology.

[Dated: Weather Bureau, Wash., Sept. 25.]

SOME HISTORICAL DATA.

Records of West Indian hurricanes are available, at least as to time and locality of occurrence, as far back as 1493, and from that year to the present 492 storms were noted, an average of little more than one each year. The great storms that reached the United States were, of course, not very numerous, yet they occurred with sufficient, though very irregular, periodicity to warrant the reasonable expectation of one every few years. Severe tropical storms visited Galveston in the years 1834, 1837, 1847, 1854, 1866, 1867, 1875, 1886, 1900, 1909, and 1915, and those of 1900 and 1915 were by far the most violent. The more severe tropical storms of recent years in the United States were:

1. The Atlantic coast storm of August, 1873.
2. The Atlantic coast storm of September, 1874.
3. The Texas storm of September, 1875.
4. The Atlantic coast storm of September, 1876.
5. The Atlantic coast storm of October, 1877.
6. The Atlantic coast storm of September, 1878.
7. The Atlantic coast storm of October, 1878.
8. The Atlantic coast storm of August, 1879.
9. The South Atlantic coast storm of August, 1881.
10. The Gulf and Atlantic coast storm of September, 1882.
11. The Atlantic storm of September, 1883.
12. The South Atlantic coast storm of August, 1885.
13. The Texas coast storm of August, 1886.
14. The Atlantic coast storm of November, 1888.
15. The Atlantic storm of September, 1889.
16. The South Atlantic coast storm of August, 1893.
17. The Gulf storm of October, 1893.
18. The Atlantic coast storm of October, 1894.
19. The Atlantic coast storm of September, 1896.
20. The Porto Rico storm of August, 1899.
21. The Galveston storm of September, 1900.
22. The Gulf storm of August, 1901.
23. The Florida storm of September, 1903.
24. The Gulf storm of September, 1906.
25. The South Atlantic storm of October, 1906.
26. The west Gulf storm of July, 1909.
27. The Gulf storm of September, 1909.
28. The Atlantic storm of October, 1909.
29. The Atlantic storm of October, 1910.
30. The South Atlantic storm of August, 1911.
31. The Gulf storm of August, 1915.

ORIGIN OF TROPICAL STORMS.

The causation of tropical storms is somewhat a matter of conjecture and theory. The subject has been more or less fully discussed by many writers, but nothing has been evolved in very recent years that is in conflict with the theory advanced by Prof. F. H. Bigelow,[1] which is as follows:

> Hurricanes occur in the southeastern parts of the United States and adjacent waters during the season of the year when the cooling of the Northern Hemisphere takes place as the sun retreats toward the Southern Hemisphere. At this season the calm belt of the Tropics and the heated, moist condition of the air in the region known as the doldrums are at their farthest northern limit. The South Atlantic permanent anticyclone, which lies over the subtropical ocean, is in its fullest vigor. Now, superposed upon these states of the lower atmosphere, the colder temperatures of the upper atmosphere, caused by the approaching autumn, on account of the more rapid circulation higher up, overspread the tropic strata near the surface. As the polar air cools first, it flows gradually above the warmer air at the south of it near the ground, and covers it with a circulating sheet of temperature cool or low for the time of year. The effect of all this is to make the atmosphere unstable, that is to say, too warm at the bottom, compared with that above it, to be able to maintain the usual equilibrium. The tendency is, therefore, for the lower air to rise vigorously and burst its way upward by convection, in order that the normal equilibrium may be restored. Of course, this action is favorable to the formation of cyclonic gyrations and the development of severe storms. Hurricanes seem to generate in some such way as this, though our observations are as yet inconclusive on that point, since there is always observed to be a stagnant, warm condition over the ocean at the time the incipient cyclonic action begins. It is to be especially considered that the isotherms in hurricanes do not show any very decided differences in temperature on opposite sides of the center, such as always prevail in the cyclones of the north. There are no counter-flowing currents here, and no source is known from which these can arise in the equatorial region to produce the marked temperature gradients found in cyclones. Furthermore, hurricanes are much more circular in shape and conform more exactly to the pure theory of cyclones as derived from the mathematical analysis.

A very large majority of the hurricanes of which there is record, occurred during the autumn or pre-autumn season, in accordance with the above, but a considerable number occurred in July, and some during the earlier months of the year, even in the winter. These, however, were probably due to some intensification of the usual contributory causation, and were not in conflict with the general idea. Again, the hurricanes of the winter, spring,

[1] Features of Hurricanes, by Prof. F. H. Bigelow. Year Book, Department of Agriculture, 1898.